Process for setting anchors and anchor

which can be used in this process

The invention relates to a process for setting of anchors such as ground anchors and rock anchors, with the features of the introductory part of claim 1.

The invention relates furthermore to an anchor which can be used in the process as claimed in the invention.

US 4,459,067 A discloses a process of the initially named type.

In this known process the anchor (rock anchor) which has a pipe which has been folded to the inside in the lengthwise direction is placed in a drilled hole and expanded by increasing the pressure within the folded pipe, so that the outside surface of the pipe rests against the inside surface of the drilled hole and thus fixes the anchor in the drilled hole.

In the known rock anchor the front end of the pipe is closed and the back end of the pipe, therefore the end which is adjacent to the opening of the drilled hole (the outer end of the drilled hole) is connected to a hose or pipe via which the pressurized fluid (especially water) can be introduced into the interior of the pipe for expanding it.

The disadvantages in the known process and the known rock anchor is that it is fixed in the drilled hole exclusively by friction and positive locking, but the beneficial side effects of an injection anchor, such as compaction of the soil or rock surrounding the drilled hole, do not occur.

The object of the invention is to devise a process of the initially mentioned type and an anchor which can be used in this process which does not have the described disadvantages, and

promptly attained and permanently reliable retention of the anchor being achieved.

This object is achieved with respect to the process with the features of the main process claim, and with respect to the anchor, with the features of the independent claim directed at the anchor.

Preferred and advantageous embodiments of the invention are the subject matter of the dependent claims.

An anchor which has been set according to the process as claimed in the invention sticks securely and permanently since it is rests securely against the inside surface of the drilled hole, because the wall of the expanded pipe of the anchor providing positive locking and friction deforms into gaps, crevices and/or areas with softer material, but also has the advantage that the rock or the soil into to which the anchor is inserted is compacted in the area of the bottom end of the drilled hole by the added hardening mass, and in any case the gaps or cracks present at the bottom of the drilled hole are filled with the mass.

The anchor as claimed in the invention is a development of known friction pipe anchors, as are known for example from the aforementioned US 4,459,067 A and which are also called "Swellex". In the anchor as claimed in the invention the force is transferred into the substratum both by means of friction and also by mechanical (positive locking-like) connection to the substratum.

The anchor as claimed in the invention also has the advantage that the anchor can also be used as an injection lance for soil improvement. Soil improvement at certain depths or starting from a certain depth is especially important if the soil layers overlying the open surface or the rock layers ahead in tunneling were affected by compaction pressure, such that under certain circumstances the entire stability of the structure is endangered.

Within the framework of the invention fundamentally anchor mortar, Portland cement and other cements with small enough grain sizes, but also synthetic resins and other injection material can be used as the hardening mass (injection material).

The hardening mass in the process as claimed in the invention can also be a hydraulically binding mass such as grout (essentially a mixture of water, cement and optionally fine aggregate such as fly ash, for example) or a mortar (essentially a mixture of water, cement and aggregate with small grain size) can be used. In this case the process as claimed in the invention still has the advantage that the interior of the anchor is protected against corrosion by the hardened mass.

The hardening mass can also be plastics which are added for example in molten liquid form and which solidify by cooling or harden after placement by chemical reaction.

In general words the procedure used in the process as claimed in the invention can be described as follows:

A drilled hole in the required length and the diameter required at the time for the pertinent product (anchor) is produced. The expandable anchor is placed in this drilled hole. Especially using an adapter the anchor is connected to a pump, filled with water and pressurized until the profile of the anchor unfolds and the pipe rests snugly against the drilled hole wall. In a further sequence the profile expands such that irregularities in the drilled hole diameter are filled. In crevices or cavities the profile expands up to its largest possible diameter, by which relative to the limited expansion in a regular drilled hole also mechanical (positive locking-like) anchoring is formed. After this is achieved, the pressure is further increased until the tip, especially in the area of a groove intended for this purpose, opens and is separated at the bottom of the drilled hole. At this point the adapter used previously, via which the water was introduced, is replaced by an injection adapter and the

injection material is delivered into the ground through the separated tip of the anchor. The grouting material (injection material) is introduced under pressure, the pressure as a result of friction and mechanical anchor-substratum bonding of the anchor which is to be dimensioned is captured accordingly such that the anchor is not pressed out of the drilled hole in the manner of a piston.

The anchor which can be used in the process as claimed in the invention on its front end, therefore on the end with which it is introduced beforehand into the drilled hole, has an end piece which is attached for example to a sleeve provided there which is connected to the pipe, the end piece opening at a pressure which is higher than the pressure applied when the pipe expands in order to place it against the inside of the drilled hole, so that then the hardening mass can be pressed through the pipe and the then open end piece can be pressed into the drilled hole.

The anchor as claimed in the invention can bear on its end which lies on the drilled hole an anchor plate which is supported on the soil or rock side on the outer end sleeve of the anchor.

Anchors as claimed in the invention can also be combined with injection drill anchors. This has the advantage that the anchor as claimed in the invention ensures prompt loadability and the injection anchor ensures long-term loadability.

Other details, features and advantages of the invention will become apparent from the following description with reference to the attached drawings.

Figure 1 schematically shows in an oblique view a rock anchor, Figure 2 shows the pipe of the rock anchor in a section in the middle area, Figure 3 shows the pipe of the rock anchor in a section in the area of one of its ends, Figure 4 shows the end piece on the front end of the rock anchor in a first embodiment, Figure 5 schematically shows the pipe of a rock anchor expanded to make contact with the inside surface of the drilled hole, Figure 6 shows the end piece of the rock

anchor in a second embodiment, Figure 7 shows the adapter receiving piece provided on the back end of the rock anchor adjacent to the drilled hole, therefore the end adjacent to the open end of the drilled hole, Figure 8 shows an adapter for introducing a pressure medium for expanding the pipe of the rock anchor, Figure 9 shows an adapter for introducing the hardening mass into the drilled hole, Figure 10 shows an anchor partially in a section, and Figure 11 shows another embodiment of an anchor partially in a section.

Even if the invention is described below primarily using the example of rock anchors as are also shown in the drawings, it should be stressed that the invention can be used fundamentally for all types of anchors, predominantly those of the initially named type, therefore also for use in soils and similar soft substratum.

The rock anchor shown in Figure 1 has a pipe 1 which has in its middle area the cross sectional shape shown in a section in Figure 2. The pipe 1 therefore has a lengthwise fold 3 pointed to the inside, the part of the wall of the pipe 1 folded to the inside in the middle area (Figure 2) appearing somewhat omega-shaped, conversely in the area of the ends of the pipe 1 the lengthwise fold 3 folded to the inside having two wall parts 5 which run essentially parallel to one another (Figure 3).

The ends of the pipe 1 which as mentioned have the cross sectional shape shown in Figure 3 are connected to sleeves 7 and 9 placed over these ends. In particular, the sleeves 7, 9 are connected to the ends of the pipes 1 by welds 11.

An end piece 13 is connected to the inner end of the pipe 1, especially to the sleeve 9 connected to this end of the pipe 1.

The end piece 13 is closed, but made such that at a certain pressure (a pressure higher than

the pressure required for expanding the pipe 1) it opens and clears access to the interior of the end piece 13 and of the pipe 1. Possible embodiments for end pieces 13 are shown in Figures 4 and 6 as well as 10 and 11.

In the embodiment shown in Figure 4 the end piece 13 has a tapering end 15 which is connected to the tubular part of the end piece 13 by a groove 17, therefore a weakening point. When a certain pressure is reached within the pipe 1, the wall of the end piece 13 breaks in the area of the groove 17 so that the end of the pipe 1 connected to the sleeve 9, for example by a weld 10, is open.

In the embodiment shown in Figure 6, the end piece 13 is made as a pipe with a free end 19 which is provided with an internal thread. A plug 21 is screwed into the internal thread so that the end piece 13 of the embodiment shown in Figure 6 is closed for the time being. When a certain internal pressure is reached in the pipe 1 or in the sleeve 9, the plug 21 is pressed out of the end 19 of the end piece 13 which is made as a plug holder, so that in this embodiment the interior of the pipe 1 is connected to the vicinity, therefore to the interior of the drilled hole.

An adapter receiving piece 31 is connected via the sleeve 7 to the other end of the pipe 1 which is shown in Figure 7 and which is opposite the inner end of the pipe 1 with the sleeve 7 and the end piece 13. For example, the adapter receiving piece 31 is connected to the sleeve 7 by a weld 33. The adapter receiving piece 31 is located in the area of the open end of the drilled hole in which the rock anchor is to be fixed. The adapter receiving piece 31 can be equipped with a non-return valve 34 which opens into the pipe 1 only in the flow direction and thus prevents the pressurized fluid and hardening mass from emerging from the rock anchor.

Either [sic] the adapter 35 shown in Figure 8 for feeding the pressurized fluid, especially water, into the interior of the pipe 1 can be connected to the adapter receiving piece 31.

Alternatively the adapter 37 which is shown in Figure 9 and which is used for forcing in the hardening mass, especially hydraulically binding mass, such as grout or mortar, can be placed on the adapter receiving piece 31.

The adapter 37 from Figure 9 can be equipped with a quick-release coupling 38 so that a hose coming from a pump which delivers the hardening mass can be quickly connected.

The adapters 35 and 37 can be provided with an outside thread 39 which can be screwed into the internal thread 41 of the adapter receiving piece 31.

Components such as for example eye bolts (DIN 580) can be attached to the adapter receiving piece 31, after the rock anchor has been fixed in a drilled hole, as is described above.

To fix the described rock anchor in a drilled hole, the procedure is as follows:

First of all, the rock anchor is inserted with its end piece 13 forward into the drilled hole produced beforehand. As soon as this has taken place, a pressurized fluid (for example, water with a pressure of roughly 100 - 500 bar) is fed into the interior of the pipe 1 via the adapter 35 which is attached to the adapter receiving piece 31 by screwing it in. Under the action of the pressure prevailing within the pipe 1, the pipe 1 expands as its lengthwise fold 3 is opened so that it is pressed with its outside surface tightly against the inside surface of the drilled hole (Figure 5). As soon as this has happened, the adapter 35 can be removed from the adapter receiving piece 31 by its being screwed off and replaced by the adapter 37 (Figure 9) and by this adapter 37 being screwed into the adapter receiving piece 31. At this point the hardening mass, especially grout or mortar which is delivered from the corresponding pump is forced in through the adapter 37 (Figure 9) under pressure. In doing so the pressure in the hardening mass is higher than the pressure prevailing beforehand when the pipe 1 is expanded by the fluid, so that the end piece 13 opens, by either

(Figure 4) the tip 15 being separated from the end piece 13 by breaking the wall in the area of the groove 17 or (Figure 6) the plug 21 being forced out of the plug holder 19. As soon as this has happened, first the fluid which has been used to expand the pipe 1, especially water, and then the hardening mass emerge from the pipe 1 via the sleeve 9 and the end piece 13 into the drilled hole. The hardening, especially hydraulically binding mass now fills the space 8 remaining after expansion of the pipe 1 between the remainder of the fold 3 and the inside surface of the drilled hole (Figure 5). In addition, the hardening mass penetrates into the cracks or fractures which proceed from the front end of the drilled hole and thus compacts the material (rock, stone, or the like) into which the rock anchor has been set, mainly in the area which surrounds the drilled hole bottom.

In one modified procedure, it can also be such that first with the fluid fed via the adapter 35 from Figure 8 a pressure is produced which is sufficient for expanding the pipe 1 as its fold 3 opens, so that the pipe 1 with its outer surface rests against the drilled hole (Figure 5), whereupon then the pressure in the fluid is raised so that the end piece 13 opens and only then is the adapter 35 from Figure 8 replaced by the adapter 37 from Figure 9.

In addition, the described procedure offers the advantage that the interior of the rock anchor which consists especially of steel is protected against corrosion. For the case in which a hydraulically binding mass based on cement is used, in addition an alkali environment is ensured; this is advantageous.

With the procedure as claimed in the invention and use of the rock anchor as claimed in the invention, in combination with injection drill anchors (so-called "hybrid anchors") the advantages of rock anchors which can be expanded using internal pressure (prompt strength and solid seating)

are combined with the advantages of injection drill anchors fixed by a hardening, for example hydraulically binding mass, since the hardening mass fills possible free spaces in the area of the drilled hole between the outside of the injection drill anchor and also penetrates into cracks or gaps which proceed from the drilled hole, and thus compacts the rock, the soil or quite generally the substratum around the drilled hole.

In the embodiment shown in Figure 10, the anchor again consists of a profile pipe 1 and the two sleeves 7 and 9 provided on its ends. The sleeves 7 and 9 are connected to the profile pipe 1 of the anchor by pressure and welding. An end piece 31 is welded to the sleeve 7 in the embodiment shown in Figure 10, and the adapter shown in Figures 8 and 9 can be alternately screwed into the end piece 31. For this purpose, the end piece 31 has an inside thread via which the coupling piece shown in Figure 8 for expanding the profile pipe 1 can be screwed in. Water is added under pressure via this coupling in order to expand the profile pipe 1 and then to blow off the tip of the anchor.

The injection adapter as shown in Figure 9 with the anchor can be connected (screwed onto) the end piece 31 after the coupling as shown in Figure 8 has been removed so that then the mass which binds the substratum can be injected.

On the front end of the anchor, via the sleeve 9 the end piece 13 is connected to the tip 15 via a weld 10. In the wall of the end piece 13 in the vicinity of the base of the tip 15 there is a groove 14 which is open to the outside. Via this groove 14 then after the expansion pressure is exceeded a material fracture is induced and subsequently the tip 15 is blown off so that then the mass binding the substratum can be injected through the anchor.

In the embodiment shown in Figure 11, the anchor again has the profile pipe 1, the sleeves 7

and 9 which are attached to the ends of the profile pipe 1 by pressing and/or welding and the end piece 31 which is connected (welded) to the sleeve 7. A coupling piece 54 which is provided with an outside thread is connected to the front sleeve 9 via a weld 55. Via this coupling piece 54 a coupling piece 53 which is provided with an inside thread is screwed, to which the weld, the end piece 13 with the tip 15 is connected [sic]. In the embodiment shown in Figure 11, the groove 17 on the base of the tip 15 is open toward the inside of the end piece 13.

The tip 15 in contrast to the embodiment shown in the drawings can be made with different angles. End pieces 13 with an arched front end (bomb-shaped) or with a flat front end can also be used.

In summary, one exemplary embodiment of the invention can be described as follows:

An anchor with a longitudinally folded pipe 1 and with an end piece 13 which can be opened under pressure and which is provided on the end of the anchor lying inside in the drilled hole is introduced into the drilled hole, and by applying internal pressure is expanded as the pipe 1 unfolds until the pipe 1 with frictional locking and/or positive locking adjoins the drilled hole, whereupon the pressure in the anchor is raised so that the forward tip 15 of the end piece 13 is separated. Then the hardening mass is pressed through the anchor into the drilled hole in order to fill cavities in the area of the anchor end located at the bottom of the drilled hole and the substratum (soil, rock) in which the anchor is fixed, and cavities or cracks located in the bordering substratum. A hydraulically binding, cement-based mass can be used especially as the hardening mass.